

COLORADO.—The State of Colorado embraces about twice as much territory as the whole of New England. The western two-thirds of the State is covered by a portion of the Rocky Mountain system, while the eastern one-third consists of the western margin of the Great Plains which gradually ascends in height from 4,000 feet on the eastern border of the State to 6,000 feet where the foothills of the Rockies begin. The foothills with their adjoining valleys vary from 6,000 to 7,000 feet in elevation.

Westward of the foothills are the natural parks, standing at altitudes between 7,000 and 10,000 feet, interspersed among the mountains of which in Colorado there are 130 peaks ranging from 13,500 to 14,500 feet.

The eastern or plain portion of the State consists of elevated plateaux which are for the most part barren of trees and vegetation save for the native buffalo grass, and the streams are few and small. This region is uninhabited except in the few widely scattered ranches and small towns.

A few miles eastward from the foothills, along the margin of the plains where they approach the mountains, are situated the most prosperous and populous towns in Colorado, and it is on this strip of land that most of the invalids locate. In the northern portion of this area, on the plains some fifteen miles from the foothills, stands the city of Denver, the capital of the State, while seventy-five miles to the south of it, and only five miles from the mountains, is Colorado Springs with its suburbs. Forty miles to the south is the manufacturing city of Pueblo, and still farther, on the borders of New Mexico, is the city of Trinidad with its important coal mines.

To the westward, in the valleys among the foothills, are found the smaller towns of Boulder, Golden, Manitou, and Cañon City.

The mountain parks are used in the summer by invalids, some of them (especially Estes Park and Manitou Park) being well supplied with accommodations for visitors. On the western side of the Rockies are many prosperous towns, which are not as much used by invalids as those of the eastern slopes because of the climate being less dry. Glenwood Springs, however, is a place much frequented by the sick, though not usually by those who are tuberculous. The varied topography of the State naturally gives rise to variations in climate, though all share in the common attributes of sunniness, dryness, and diminished barometric pressure. In the eastern or plain portion is to be found the most sunshine and least humidity, but with more dust and wind than in the sheltered valleys and parks of the mountain regions. The average annual rainfall is fifteen inches. The range of the greatest annual extremes is not more than ten inches, while on the coast of California it extends to thirty-nine inches. The rain is naturally more copious on and near the mountain peaks, and at this great height it usually though not invariably increases with the altitude. On the eastern side of the main range the bulk of the precipitation occurs during the summer half of the year, there being no rain through the winter and very little snow. On the western, or Pacific slope, on the other hand, the precipitation during the winter six months is somewhat greater than in the summer. The mean relative humidity of Colorado is 50 per cent., and the actual humidity 2.04 grains per cubic foot of air, the average annual temperature being 50° F. This dryness of the air causes both the heat and the cold to be better borne for reasons which are so well explained by Professor Harrington in his paper upon sensible temperatures to be found in the transactions of the American Climatological Association (vol. x.).

"The sun in Colorado, in that great tract along and among the eastern foothills, in which are located Denver, Colorado Springs, Manitou, Pueblo, Trinidad, Golden, Boulder, Fort Collins, and Greeley; in that region to which the tourist and the invalid are most likely to come, and in which they are likely to stay longest—the sun here shines for about sixty-two hours out of every hundred in which it is above the horizon. In Philadelphia the ratio

is forty-nine. During the winter months, the trying time for the invalid, the difference is more striking still. In Colorado we have from December to March, 56 per cent. of all possible sunshine. In Philadelphia they get but 37 per cent.; a difference in Colorado's favor of over one-half. In ten years there were in Denver, on the average in each year, 314 clear or partly clear days. In Chicago, in the same period, there were only 251; in New York, 262. During the three winter months the sun shines four out of every five days. Nor do these figures tell the whole story. One of the greatest advantages of this eastern belt along the front of the range is the early morning sunshine. There are no high mountain ranges for the sun to climb, as in so many high altitude resorts in other lands, but its first rays above the low eastern horizon are at once warming and cheering. The sun is up before the invalid is awake, and the air is warmed for his outdoor life without a long wait till mid-morning. In Davos, Switzerland, the sun on January 1st does not rise till 10 A.M., and sets at three in the afternoon, a possible sunshine of only five hours. In Denver on January 1st the sun rises at 7:30 A.M. and does not set till after 4:30 P.M.; more than nine hours of sunshine.

"Neither do the few cloudy days preclude an outdoor life, as might be inferred. They do not bring the damp and rawness of the Eastern or Middle States. To many there is a restfulness in a clouded day from the constant intensity of clear blue sky."*

The temperature of the air in the sunlight and in the shade varies from 40° to 60° F. There is a large amount of electricity and marked diathermaney of the air.

The wind movement of Colorado is high, especially on the plains, though it is not as high as that of the most important cities of the Union.

Through the country, where the plains and mountains meet, the seasons may be thus briefly described: March is usually dry and a pleasant month with but few storms. April is, perhaps, the most disagreeable month of the year, as in the first half wet snow storms or heavy rains are usual. In May the weather improves, and in the last half of the month it is generally good. June is dry and warm. Through July and August the summer heat is not excessive, the mornings and evenings being bright and beautiful, while in the afternoons heavy thunder showers lasting some twenty minutes are usual. By the middle of September the rains have ceased, and beautiful, dry, sunny autumn weather is experienced usually until the turn of the year. In January and February the coldest weather occurs, but as it is dry, clear, and sunny it is bracing and pleasant, except to those who are too feeble to react to its tonic effects.

Dr. C. T. Williams, in describing the quality and effect of the various factors of the Colorado climate, writes as follows: "Thus the climate of Colorado is dry and sunny, with bracing and energizing qualities, permitting outdoor exercise every day all the year round, the favorable results of which may be seen in the large number of former consumptives whom it has rescued from the life of invalidism and converted into healthy, active workers."[†]

Boulder—elevation 5,300 feet, population 5,000, latitude 40°. This little town is situated at the mouth of Boulder cañon, some thirty miles northwest from Denver. The State University of Colorado is here, and there is also a sanitarium which is a branch of the Battle Creek sanitarium. Comfortable accommodations can be obtained at the hotel and boarding-houses. The mean temperatures (Fahr.) as recorded are: spring, 49°; summer, 65°; autumn, 49°; winter, 24°. Total rainfall, 19.21 in.; spring, 8 in.; summer, 7.7 in.; autumn, 2 in.; winter, 1.51 in. The humidity and wind movement observations are not to be obtained. The soil is sandy. The water supply is good, but there is no system of sewerage.

Cañon City—elevation 5,300, latitude 38° 30'; population 4,500. Cañon City lies in a valley close to the en-

* Colorado: "About its Climate," by J. C. Dana, Librarian, and Carroll E. Edson, M.D., Denver, Col.
† "Aerotherapeutics," by Charles Theodore Williams, M.D., London.

trance to the Grand Cañon of the Arkansas. It is forty-five miles northwest of Pueblo. It is well sheltered from winds, except where an occasional westerly wind blows through the cañon. It has a mild winter climate. The soil is mostly adobe, so it is slow in drying up after rain and snow. The water supply is good. There are fair hotels and boarding-houses, and the prices are moderate. The streets are pleasantly shaded with trees. Fruit growing is successfully carried on by irrigation throughout the valley. There are hot and cold soda springs. The seasonal temperatures (Fahr.) and rainfall are as follows: Spring temperature 52°, rainfall 4.2 in.; summer temperature 72°, rainfall 4.2 in.; autumn temperature 53°, rainfall 1.6 in.; winter temperature 34°, rainfall 1.8 in.

Colorado Springs—elevation 6,000 feet; latitude 38° 51'; population 30,000. Colorado Springs is situated seventy-

the curve lies, as it were, in a bay opening southward to the ocean plain."*

In looking landward from the town it will be noticed how it is encircled by ramparts formed by the ground rising from 6,500 feet on the east up to 7,000 feet on the north, and sloping upward along the western line to over 14,000 feet upon the summit of the Peak and southward again to the 6,500 foot level. The ramparts formed by the mountains afford shelter from the sweep of the continental storms and by their attraction keep back much of the rain and snow that gather around the Peak. The lofty eminence of this grand mountain, piercing the upper cooler strata of the atmosphere, draws toward it the clouds which, as they break, pass southward over Cheyenne Mountain and northward over the Front Range, and thus eastward along the ridge of the Divide.

The heavy trans-continental storms coming from the



FIG. 1470.—Manitou, Colorado, on the Denver and Rio Grande Railroad.

five miles south of Denver on the mountain shore fringing the ocean of the Great Plains. "These plains, which begin to rise eight hundred miles away to the eastward and stretch an equal distance north and south, have been called the Great American Desert. This great plateau is almost completely barren of trees and crops, and is traversed by a few slender streams. The arid soil yields but little water from infrequent wells and springs, and the dry air blowing over this plateau gives but scant moisture; so that there are only a few scattered oases of cultivation in this vast expanse of grassy plain. To the eye the rolling prairie conveys the impression of the sea, and, no doubt, it was this thought that prompted the early pioneers to call their wagons as they slowly lumbered over the plain 'prairie schooners,' the wagon covers in the distance resembling sails.

"The town has in the west, towering eight thousand feet above it, that great sentinel of the Rockies, Pike's Peak, with its shoulders sloping to the lower heights of Cheyenne Mountain in the south and melting into the Front Range in the north, with a spur, the Divide. This Divide projects from the front range to the eastward, with its crest being twenty-five miles north of the town, and curving southward; it therefore shelters the city on the north and east. These mountains and their spurs form a semicircle. The town situated in the depth of

west over the mountains, for the most part, do not strike the plains short of fifteen miles to the eastward, because of the great width of the angle at which they descend by reason of their great velocity and the height of the mountains they have to cross, thus leaving the town in the wind-shed below. This sheltered position does not, however, prevent the town from experiencing on these occasions much movement of the air from the eddying currents set in motion by the storms that pass over and around it.

Perhaps one of the strongest features in the resemblance to a seashore is in the customary daily variations of the local winds. Wherever the land and ocean meet there is a daily breeze blowing from the sea to the land and a nightly one from the land to the sea. Here we have in the diurnal winds an exact counterpart of the sea and land breezes. In ordinary weather, throughout the night, a gentle breeze blows from the north and northwest, and as the sun begins to rise the wind shifts eastward and, passing south, blows from the southwest during the early afternoon; then turning backward through the eastern quarter it reaches the north once more as the sun goes down, where it lingers through the night. The velocity of the

* "An Inland Seashore," by S. E. Solly, M.D., Mountain Sunshine, Fall Number, vol. i., 1899, p. 2, Colorado Springs.

wind is very slight during the hours of darkness, but increases after daybreak up to two or three o'clock in the afternoon when it blows with its maximum force, gradually dying down again as sunset approaches and it returns to the northern quarter. Thus we have by day a sea or plain breeze, by night a shore or mountain breeze.

The customary winds are, however, very different in their quality from those on the seashore, because they are dry instead of moist. This is particularly the case in contrasting the sea and plain winds. The winds passing over the ocean toward the shore must, from the very nature of things, bring with them much humidity, so that in whatever climate a sea breeze blows it is always damp and there can be only relative dryness in sea breezes, but owing to the varying temperatures its effects may be very different. For instance, on a seashore where there are brilliant sunlight and genial warmth, as on the coast of Southern California, through the warmer hours of the day the sea breeze blows and does not part with its humidity as rain or fog. During the early morning and evening hours the change of temperature is usually too slight to cause a fall of rain, but the moisture in the air condenses to a light fog. This condition is practically the same both summer and winter in California, but on the North Atlantic coast the conditions are only similar during the summer, while in winter the greater cold brings harsh weather with increased precipitation. The great and important difference between this fancied seashore and a real one is that it is dry instead of moist, though they are alike in this, that breezes bring an abundance of pure air which has blown over surfaces untainted by malaria or the habitations of man. It is the proximity of the great plains with their dry, treeless, and sparsely populated soil that gives to Colorado Springs such a magnificent reservoir of pure, sun-dried air for it to draw upon.

The open aspect to the south and east with the sloping southern shoulder of the Peak, allows longer hours of

In the Alpine valley resorts the daily breeze blows more gently over chilly mountain tops or ice fields, bringing a much cooler and slightly damper atmosphere than that which reaches Colorado Springs from the plains. While the qualities of the Colorado Springs diurnal winds are suited and agreeable to many, yet for others the greater coolness and lesser velocity of the daily breeze experienced in Davos are more to be preferred.

The plateau upon which the town stands is composed of sand and gravel, rising some seventy feet above the clay bed of the streams. In this soil no water is to be found and the city is dependent upon water brought from the mountains. The surface of the plateau thus lifted above the river valleys is level and has a gentle slope from north to south, which allows good natural drainage and easy sewerage. When one is standing on the town site, the elevation of this plateau above its immediate surroundings conveys the impression of height; but on looking down upon the town from the encircling benches or hills, we then see that it really rests in the hollow of a bay with two sheltering arms stretching out from Pike's Peak around it to the north and east, and to the south and west, leaving the southeastern aspect open to the plains.

Occasionally during the winter half of the year the wind will remain throughout the day in the northern quarter, bringing cold, stormy weather from across the mountains; though when the thermometer drops near or below zero, as it occasionally does, the wind usually also abates, so that the intense cold is quite endurable and even pleasant if the body is well protected by warm clothing. It is also a rare day when the sun does not shine. During the nights, which are usually the coldest portion of the twenty-four hours, there is rarely much wind blowing. After a cold snap, when snow has fallen, often the chinook—a warm, dry wind which rapidly melts the snow and dries the ground—will blow from the west. It is similar to the föhn wind of Switzerland, which is sometimes called "the snow eater." The velocity of

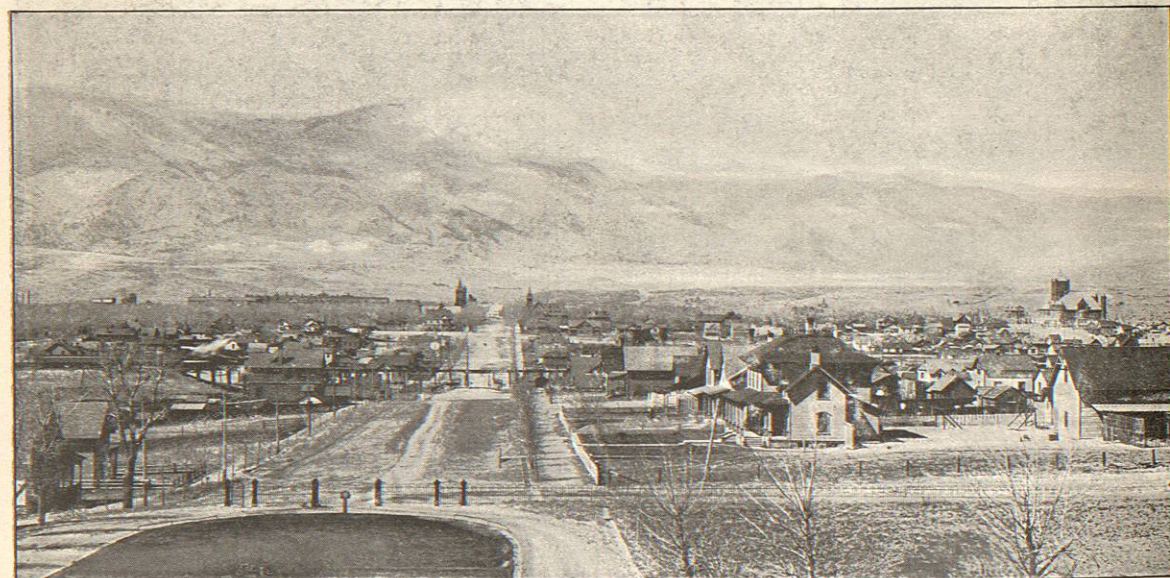


FIG. 1471.—Colorado Springs, on the Rio Grande Railroad, with Pike's Peak in the Distance.

sunshine and intenser light than are found in the Swiss mountain valley resorts. For instance, on the first day of January the possible hours of sunlight in Davos are four hours, whereas in Colorado Springs they are nine.

the chinook is very great, but it rarely blows more than a few hours at a time. Winds from the west and southwest are infrequent, but in addition to those which have been mentioned occasional local breezes will spring up,

blowing from the west, but not of high velocity or of long duration.

The mean total monthly wind movement is at Colorado Springs, 6,663 miles; New York, 6,883; Boston, 7,997; Chicago, 7,007; St. Louis, 7,011; San Francisco, 6,863. These places all show a greater amount of wind move-

Asheville, 48 at Aiken, 51 at Thomasville, 30.5 at San Antonio, and 18 at Santa Barbara. In autumn the precipitation is not more than two inches.

The annual average relative humidity of Colorado Springs is 50 per cent., being 19 per cent. less than Asheville, 15 per cent. less than Thomasville, 18 per cent. less

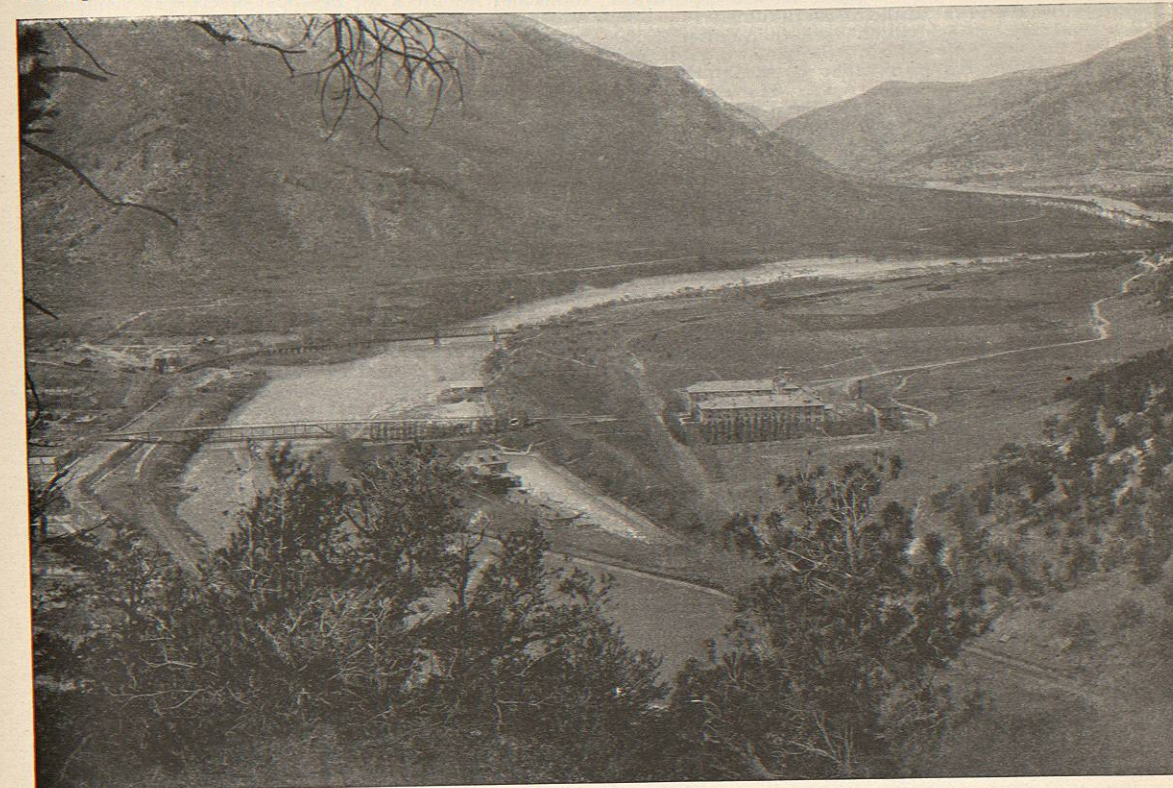


FIG. 1472.—Glenwood Springs, Colorado, on the Western Slope of the Rocky Mountains. Elevation, 5,200 feet. View of hotel, bath-houses, and pool.

ment than Colorado Springs, while, on the other hand, in the following places the wind movement is somewhat less: At St. Paul it is 5,156 miles; San Antonio, 5,301; San Diego, 4,105; Thomasville, 4,225; Denver, 4,980, and Pueblo, 5,438. This average annual monthly movement of the wind at Colorado Springs is largely augmented by the spring gales, the autumn and early winter being much less windy.

The hourly wind velocity at Colorado Springs during the autumn is nine miles per hour, being only slightly greater than that of the summer season, and quite a little less than that of the winter and spring.

The number of cloudy days of the entire year is very small, averaging but 57 as against 129 in the Adirondacks, 106 at Asheville, 97 at Thomasville, 92 at San Antonio, and 73 at Santa Barbara. In the principal cities of the Union—Boston, New York, Chicago, St. Louis, and San Francisco—the number of cloudy days range from 88 at San Francisco to 117 at Chicago. Of the 57 cloudy days which occur through the year at Colorado Springs the fewest are seen during the autumn, averaging less than half the number in the summer and winter and one-third of the number during the spring, which is the cloudiest season.

The annual average rain and melted snow fall is 14.5 inches, as contrasted with 39 in the Adirondacks, 45 at

than San Antonio, and 23 three per cent. less than Santa Barbara. In the autumn it is about 4 per cent. higher than in the winter and summer, and 8 per cent. higher than during the spring. This is because of the diminished precipitation; a little more moisture being retained in the air.

The annual average absolute humidity of Colorado Springs is 1.48 grains as against 3.24 grains for Asheville, or 4.86 for Thomasville, or 5.26 for San Antonio and 4.20 for Santa Barbara. In the autumn the absolute humidity in Colorado Springs is 2.05, which is very low, though slightly in excess of the annual average.

The average temperature (Fahr.) for autumn of Colorado Springs is 48°, contrasted with 43° in the Adirondacks, 53° at Asheville, and 61° at Aiken, 62° at Santa Barbara, and 34° at Davos-Platz.

The average night temperature of Colorado Springs for the autumn is 34°, being about the same as that of the spring; while in summer it rises to 51° and in winter drops to 17° F., owing to the cold but still night.

Colorado Springs has a complete system of sewerage, electric lights, and electric street cars. The water supply is brought in pipes from the mountains and is abundant and pure. The wide, level streets are shaded by trees. There are excellent stores, four banks, two theatres, and several first-class hotels. The Antlers, recently rebuilt,

is the most complete hotel in the West: it is fireproof and stands in a beautiful park. A fine social club house and two country clubs are adjacent. The churches are numerous and well served. The residences are detached, with gardens and trees around them, and are for the most part pleasing in their architecture. The general air and resources of the city suggest the best type of the Eastern rather than that of the Western States.

Glenwood Springs—elevation 5,200, population 1,500—lies on the western slope of the great continental Divide, and is situated in a valley at the junction of the Grand and Roaring Fork rivers. The Denver and Rio Grande and the Colorado Midland railways pass through the town on their way from Denver to Salt Lake and the Pacific coast. Here is the far-famed Yampa hot spring, from which flows each minute 2,000 gallons of water at a temperature of 134° F. This water is rich in salts, and sulphureted hydrogen gas is freely given off from its surface. The arrangements for bathing are of the most complete and modern description. There is an open swimming pool 700 feet in length and 100 feet in width, in which a hot salt bath can be thoroughly enjoyed. On one side of this pool is a beautiful bathhouse containing baths of all kinds; on the other are sulphurous vapor caves which are most comfortably fitted up. The baths of Glenwood are justly celebrated for their efficacy in the treatment of various diseases, especially gout, rheumatism, syphilis, and certain renal and hepatic affections. Its climate is soothing and restful and of great service in irritable nervous disorders.

"Glenwood Springs has one of the finest hotels in the West. It is a large building in the Italian style of architecture, constructed of Colorado peach-blow-colored stone and Roman brick. It surrounds an open court which is terraced, and has grass plats, fountains, and beds of flowers. The hotel has 200 guest rooms; it is well heated, liberally supplied with open fireplaces, and is lighted by electricity."*

CLIMATIC CONDITIONS AT GLENWOOD SPRINGS.

Monthly mean temperature (Fahr.)—	
Winter.....	27°
Spring.....	50
Summer.....	69
Autumn.....	47
Year.....	48
Rainfall (total, inches)—	
Winter.....	4.90
Spring.....	3.04
Summer.....	3.80
Autumn.....	4.22
Year.....	15.96
Monthly mean temperature for January (two years).....	22°
Monthly mean temperature for July (two years).....	72°
Mean yearly minimum (three years).....	5°
Mean yearly maximum (three years).....	100°

Therapeutic Use of Colorado.—What has been written about the use of high stations in the Alps applies to Colorado with certain modifications. The latitude of Colorado is much lower than that of the Alps, that of Colorado Springs being about the same as that of Naples. It is therefore much warmer, and also, because of its situation in the interior of the continent, much dryer; moreover, it enjoys the climate of the high plateau as well as that of the mountain. This increases the dryness, the length of sunshine, and also the windiness of the climate. If the reader will turn to the description of Colorado Springs, he will understand how this health station combines the features of a plateau and a mountain station in a remarkable degree. The other places mentioned in this article, except Denver and Pueblo, lie more in the mountains, and receive more shelter but less sunshine, and are less under the influence of the air of the plains. When Colorado was first visited as a health resort, the idea was that it was better to place stations, particularly for consumptives, in the more sheltered resorts. For instance, Manitou and Cañon City were greatly used, and Colorado Springs very lit-

*Solly's Handbook on "Climatology," p. 251.

tle; but the experience of the patients and of the doctors brought about a change in this respect, and, in spite of the accommodations being inferior at that time, patients frequented Colorado Springs in large numbers to the neglect of the sheltered resorts. At the present time, and indeed for some years past, the accommodations and resources for invalids have been excellent at Colorado Springs, and far better than in any other resort in the Rocky Mountain region. The wisdom of this change of base has been proved by the local experience, and is further corroborated by the successful use of open-air treatment in England and elsewhere, where the exposure to wind and stormy weather is much greater than in Colorado Springs. At the same time, the more sheltered spots are of greater service to a few of the cases. While, in comparing Colorado Springs with the Alpine resorts, we find that it excels them in the amount of sunshine and dryness, and because the climate is less harsh, we must at the same time admit that it falls behind them in that there is more wind and dust. One of the most prominent advantages that Colorado Springs enjoys—an advantage which is also shared in a lesser degree by the other Colorado resorts—is that the consumptive patient can continue under the influence of the climate all the year round, there being no falling and melting snow periods as in the Alps. To this the writer attaches great importance, because he does not believe that in seriously affected cases a residence of a few months is sufficient to insure permanent results. Further, when the consumptive is able to move about and take exercise, he has a wide area over which he can pass; he can ride and drive, play golf, and vary his amusements. Also, at Colorado Springs, at least, he can have the advantage of literary and musical circles, and all kinds of educational and religious institutions, and find reasonable social distractions. Those also in whom the disease is arrested, but for whom it is inexpedient that they should return to their former home, or who do not desire to do so, can find opportunities for work or investment of money. The recent discoveries of gold at Cripple Creek have added to the wealth and prosperity of the city, and to the business opportunities of all kinds, but have not brought any of the objectionable features of the mining camp. Besides the resources of the town, there are beautiful environs in which patients can live or to which they can resort by day.

It is often urged that for a consumptive who, of necessity or by choice, returns to his home, it is far better that he be treated in the same climate. There are undoubtedly many cases, particularly those in an early stage, in which this can be done, or must be tried; but the objection which is often made, viz., that the patient in whom the disease is arrested in a different climate, especially that of an altitude, is unable to return with safety to his home climate, does not hold. The writer in his visits to England and the Atlantic seaboard of America frequently has the pleasure of meeting old patients who have recovered in Colorado, and who are continuing in good health in their former homes. It is chiefly a question of care, especially in the first months of their return, during the period of re-acclimatization. As Sir Herman Weber and other writers of eminence have said, a patient cured in a high altitude is just as much cured as one cured elsewhere, and if a patient's condition is such as to justify his return home, provided he has acquired the hygienic education that he should receive from his physician, he can do so without fear. Of course, in sending a patient far from home, his pecuniary, domestic, and social circumstances have to be very carefully investigated and considered before such a step is taken. Nostalgia is the curse of many patients, though it is surprisingly less under the sunny and stimulating influence of a high altitude than in resorts where cloudy weather and sedative influences dominate.

The journey to Colorado, owing to the distance, is usually expensive, and the cost of living ranges about twenty-five per cent. higher than in most of the cities at sea level, but is very little if any greater than in the

generality of health-resorts. Fair accommodations can be secured at a dollar a day, but for the well-to-do they would range from one and one-half to two and one-half per day. This applies to boarding-houses, which are both numerous and of all qualities. The best hotels charge from three to five dollars a day, somewhat lower rates being secured by the week.

The writer believes, and statistics confirm the belief, that in properly selected cases the arrest which is brought about in an altitude is more rapid and more lasting than that which has been procured in low places, this being probably mainly due to the fact that the changes in the blood quickly remove the anemia. Open-air life is possible and agreeable for the whole twenty-four hours throughout the year, except during occasionally stormy spells, many patients sleeping out upon balconies through all the seasons. The statement is undoubtedly true that for most consumptives cold is better than heat; therefore the majority of consumptives improve more in the cool air of Colorado than in the warm air of New Mexico and Arizona. However, fibroid patients, in whom the circulation is feeble, and catarrhal individuals, to whom the variations of weather are dangerous, improve more surely during the winter in the warmer climates of New Mexico and Arizona, although in the summer time the cool, temperate weather of Colorado suits them better than the extreme heat of Arizona and New Mexico. If the reader has studied the meteorology of this region, and has read the article upon *Altitude*, he will appreciate the indications for selecting Colorado Springs or the other resorts which have been described, and also will appreciate the principles upon which the choice of an altitude should be made.

S. Edwin Solly.

COLORING MATTERS, ANIMAL.—Many of the animal coloring matters are substances of considerable functional consequence. Some, for example, are of special service in respiration; others appear to be important factors in vision; a large number afford protective effects; several, also, are attractive in their influence. A majority, however, seem to be without any apparent physiological relations and not a few are purely excretory products.

I. CLASSIFICATION.

The multitude of animal pigments may be arranged conveniently in the following general groups:

1. **RESPIRATORY PIGMENTS.**—These coloring matters are very important functionally. Most of them are carriers of oxygen, with which they unite loosely, receiving it in the organs of respiration, conveying it to the body parts, and there giving it up to the tissues. The leading ones are compound ("chromo") proteids. Among them are hæmoglobin, hæmocyanin, hæmerythrin, and chlorocruorin.

2. **DERIVATIVES OF RESPIRATORY PIGMENTS.**—Some of the best-known animal coloring matters are derivatives of hæmoglobin, and many of the colored substances in the lower animals are undoubtedly formed from their blood pigments. Prominent derivatives of hæmoglobin are bilirubin (hæmatoidin), stercobilin (urobilin), urochrom, and hæmatoporphyrin.

3. **LIPICHROMES.**—These substances, yellow or yellowish red for the most part, are very numerous. They are found particularly in adipose tissue, yolk of egg, butter, and in the tissues and epidermal structures of the lower animals. In solubilities they are much like the fats, and they show absorption bands toward the violet end of the spectrum. Little is known of their chemical composition. They appear to consist of only carbon, hydrogen, and oxygen. Among them are serum lutein, tetron erythrin, and the "chromophanes."

4. **MELANINS.**—These are brownish-black pigments occurring especially in epidermal structures. They consist of carbon, hydrogen, nitrogen, and oxygen. Nearly all contain sulphur; a few, iron. It is thought by some that they are derivatives of hæmoglobin; by others, modified lipochromes. They have been produced out-

side of the body from simple proteids by prolonged hydration ("melanoidins"), which fact suggests, of course, that they may be so derived within the system. Among the typical members of the group are fuscine, phymatorhusin, and sepic acid.

5. **CHROMOGENS.**—These are the colorless, or less colored, precursors of actual pigments occurring in nature. The leading ones are indoxyl compounds, which give rise to red and blue indigo; melanogen; uroscinogen; the chromogen of the suprarenal medulla, related probably to the pigment of the skin in Addison's disease; and urobilinogen. The so-called "humous substances," obtained by destructive chemical methods, and such bodies as proteinochromogen (tryptophan), which merely form colored combinations with various reagents, are, of course, purposely excluded here.

6. **MISCELLANEOUS PIGMENTS.**—This residual group includes a very large number of protective, attractive, and other coloring matters, characteristic especially of the lower animals, studied only spectroscopically for the most part. Among those whose chemical individuality is not disputed are turacin, carminic acid, punicin, chlorophyll, and lepidotic acid.

II. DISTRIBUTION.

LOWER ANIMALS.—Coloring matters are widely distributed throughout the whole of the animal kingdom. In some animals they occur only in the body fluids, in others they are also diffused throughout various tissues. In many they occur in the form of granules in certain cells or cellular layers. Many of the lowest types, such as infusoria, sponges, and hydroids, contain *chlorophyll* (green) in granular form and some ciliated animalcules are colored by *stentorin* (blue). Chlorophyll is found in several mollusks, crustacea, and insects, and also in the so-called livers of many invertebrates (*enterochlorophyll*). The latter organs also contain a ferruginous pigment, *ferrin* (brown) and *cholechrom* or *hepatochrom* (reddish yellow), a lipochrom; also *helicorubin* (orange red). *Hæmatoporphyrin* (purplish red), a derivative of *hæmoglobin* (red), occurs in the integument of star fishes, slugs, the common earthworm, and various sponges. A number of corals and hydroids, and some sea anemones, are colored by *actinochrom* (red); also by *polyperylthrin* (red), probably identical with hæmatoporphyrin. Some actinæ contain a coloring matter very similar to another derivative of hæmoglobin, *hæmochromogen* (red), and convertible into hæmatoporphyrin. Many echinoderms contain *pentacrinin* (red and purple) and the following pigments give special coloration to the lower species from which the terms are derived: *aplysiopurpurin* (purple), *bonellein* (green), *echinastarin* (red), *astroidin* (yellow), *rhizostomin* (violet), *ophiurin* (yellowish brown), *asterocyanin* (bluish violet) and *comatuln* (red). *Punicin* (purple) is derived from the colorless secretions of various mollusks on exposure to light, and *carminic acid* (red) is the pigment characteristic of the cochineal.

The shells of some mollusks, and also some corals, contain "lipochromoids" and "melanoids." The brownish-black ink of *Sepia officinalis*, used to color the sea water and cover the flight of the animal, contains a melanin, *sepic acid* (black). The green (*chlorophan*), yellow (*xanthophan*), and red (*rhodophan*) pigments, "chromophanes," of the oil droplets in the retinal cones of birds, reptiles, and fishes, as well as the yellow substance in the yolk of egg (*ontochrin*), are lipochromes. The egg of the water spider is colored by the two lipochromes, *vitellorubin* (red) and *vitellolutein* (yellow). Some of the characteristic coloring matters in decapod crustacea are lipochromes. The red *crustaceorubin* is closely related to hepatochrom (cholechrom) in the livers of these animals. The eggs of the river crab and the lobster contain the same bluish pigment as that in the carapace of the animals. This pigment, called *cyanoerythrin*, becomes red with acid and on boiling in water. Crustaceorubin appears to be derived from it. The shells of various birds' eggs are pigmented by hæmoglobin derivatives, among which are